Section 821
Issue No. 2
Addendum No. 2
May 1962

Reprinted May 1978

MULTIPAIR DISTRIBUTION WIRE PROTECTION

(ELECTRICAL PROTECTION OF FIGURE 8 ONE-PAIR AND FIGURE 8 MULTIPAIR DISTRIBUTION WIRE)

Purpose: The purpose of this addendum is to provide information on the electrical protection requirements for Figure 8 one-pair and multipair distribution wires. REA TE & CM-821, "Multipair Distribution Wire Protection," dated July 1959 and Addendum No. 1 dated April 1961, remain in effect for PE-15 distribution wire. The new material is as follows:

GENERAL LIGHTNING CONSIDERATIONS

1.01 This addendum applies to Figure 8 multipair distribution wire covered by REA Specification PE-28, and Figure 8 one-pair distribution wire covered by REA Specification PE-27.

Throughout this Addendum, Figure 8 multipair distribution wire is referred to as "Fig. 8 MPDW." Figure 8 one-pair distribution wire is referred to as "Fig. 8 one-pair DW." Where the same information applies to both types of wire the term "Fig. 8 DW" is used.

1.02 The actual surge dielectric strength of Fig. 8 DW is not yet available. From known data however the surge dielectric strength of Fig. 8 MPDW is conservatively estimated to be 20 kv between conductors and greater than 95 kv from conductors to the support wire. The surge dielectric strength of Fig. 8 one-pair DW is conservatively estimated to be 25 kv between conductors and greater than 60 kv from conductors to the support wire.

1.03 These dielectric strengths are adequate to prevent damage from lightning surges except for direct strokes and those arising from connections to stations that are severly exposed such as fire towers, radio stations, etc. There is no economically feasible way to protect aerial facilities against direct strokes and therefore no attempt is made to do so. The dielectric strength of Fig. 8 types of DW between conductors and the support wire is so great that the provision of air gap arresters from conductors to support wire is not essential from protection considerations.

Because of differences in potential between conductors which can arise during the passage of surges, washer gaps are desirable in some situations to limit these potentials as described herein. The provision of a metallic path from washer gap terminal blocks to ground is not necessary except for unusually severe surges. Because the dielectric strength from the outside of the jacket to the support wire is substantially less than the dielectric strength from conductors to support wire, ready access enclosures can be mounted by clamping over the support wire insulation. Unusually severe surges would then cause breakdown between the clamps and the support wire before dielectric failure between the conductors and the support wire would occur.

2. GENERAL POWER CONTACT CONSIDERATIONS

2.01 With outside plant wire and cable of all types, the most effective measures in the prevention of power contacts lie in the provision of sound construction, proper clearances, and avoidance of nonstandard conditions. Because Fig. 8 DW will be twisted around its support wire during construction, power conductors can make physical contact with either the jacket over the support wire or the jacket over the conductors. For design purposes the 60-cycle dielectric strength of the Fig. 8 MPDW is conservatively estimated to be 30 kv from conductors to the outside and 20 kv from the support wire to the outside. The Fig. 8 one-pair DW is estimated to have a 60 cycle dielectric strength of 19 kv from conductors to the outside and 12 kv from the support wire to the outside.

2.02 In the event of a physical power contact to Fig. 8 MPDW or Fig. 8 one-pair DW, no electrical contact would occur unless and until dielectric failure of the jacket over the support wire or failure of the jacket and insulation over the conductors occurred. The heat of the arc resulting from dielectric breakdown would melt the jacket and insulation from the wire at the point of contact thereby establishing a direct or arcing contact to the support wire. Coordinated protection can therefore be obtained by effectively grounding the support wire as described in paragraph 5.01. The probability of a contact to the conductors which would not involve the support wire is so small that the application of power contact protectors between conductors and the support wire, of either Fig. 8 MPDW or Fig. 8 one-pair DW cannot be justified.

Station protection in conjunction with #24-gauge copper leads or a #20-gauge 30% conductivity copper-steel bridle wire (hereinafter referred to as #20-gauge bridle wire) fuse link between the Fig. 8 DW and the drop wire will provide adequate protection to telephone users and to subscribers' premises.

2.03 The National Electrical Safety Code (NESC) has not recognized Fig. 8 DW as being immune to power contacts so all applicable provisions of the NESC for "communication conductors" should generally be met. However, because this type of facility was not contemplated when the NESC was written, some latitude of engineering judgment within the intent of the NESC requirements is permissible. In this connection REA considers joint use, crossings, and conflicts (if they cannot be avoided) of Fig. 8 DW with Grade C power line construction permissible without specific measures to obtain coordinated protection other than grounding the support wire. If local authorities question this interpretation, Grade B construction of the power line should be provided.

3. GENERAL LOW FREQUENCY ELECTRIC INDUCTION CONSIDERATIONS

3.01 Voltages are induced electrically in Fig. 8 DW from exposures to 60 cps power systems in the same manner as in open wire circuits. The magnitude of the induced voltage however is much lower in the case of Fig. 8 DW than in the case of open wire because there is much greater capacitance between the conductors and the grounded support wire of Fig. 8 DW than there is between open wire conductors and ground. Drainage units are <u>not</u> required.

4. SPECIFIC LIGHTNING PROTECTION MEASURES APPLICABLE TO FIGURE 8 DW

4.01 <u>Junctions of Fig. 8 DW with Aerial Plastic Insulated Cable</u>

Although there is an appreciable difference in the conductor-to-support wire surge dielectric strength of Fig. 8 DW, and the conductor-to-shield dielectric strength of aerial plastic insulated (PIC) cable, both facilities have a sufficiently high dielectric strength to withstand most surges and it is unlikely that either facility would be damaged by surges fed from the other. Fig. 8 DW may therefore be spliced directly to PIC cable conductors without washer gaps or other lightning protection measures.

4.02 <u>Junction of Fig. 8 DW with Paper Insulated Cable</u> - Lightning protection of paper insulated cable (by means of 700 volts rms. carbon blocks) at junctions with Fig. 8 DW is required in accordance with REA TE & CM-815, "Cable Circuit Protection.

4.03 Junctions of Fig. 8 DW with Open Wire - Because of the large differences in potential that can exist between conductors of an open wire pair, and because of the considerably greater dielectric strength between conductors of open wire as compared to Fig. 8 DW, lightning protection in the form of washer gaps should be provided at such junctions.

4.04 Junctions of Fig. 8 DW with Other Fig. 8 DW - No protection is required.

4.05 Junctions of Fig. 8 DW with Old Type MPDW (REA Specification PE-15) - Splicing and terminating considerations are of more importance than lightning protection because the probability of lightning damage to either of these facilities is small. Because it is not practicable to splice these conductors directly together, the conductors of PE-15 MPDW and the Fig. 8 DW should be terminated on binding posts of terminal blocks. Washer gap terminal blocks without leads mounted in ready access enclosures are recommended for this purpose.

4.06 Junctions of Fig. 8 DW with Old Type One-Pair DW - (REA Specification PE-17) - The probability of lightning damage to either of these facilities is small; therefore, splicing and terminating considerations are controlling. Because it is not practical to terminate PE-17 conductors on binding posts, bridle wire must be run from the PE-17 wire to the Fig. 8 DW. The bridle wire should be connected to binding posts on a washer gap terminal block without leads mounted in a ready access enclosure on Fig. 8 MPDW, or to a wire-mounted terminal on the Fig. 8 one-pair DW.

4.07 Junctions of Fig. 8 DW with Drop Wires - Lightning protection is not essential. However, terminal blocks to which #24-gauge leads or #20-gauge bridle wire conductors are connected are normally required for termination and station protection reasons (see paragraph 5.03). Washer gap terminal blocks are recommended for Fig. 8 MPDW. There is no suitable one-pair washer gap terminal available for Fig. 8 one-pair DW.

4.08 Junctions of Fig. 8 DW with Buried Cable - There is no specific requirement for lightning protection at junctions of Fig. 8 DW with buried cable. However, terminal blocks to which 24-gauge leads are connected are usually required at such junctions in connection with the protection of stations along the buried cable. Washer gap terminal blocks are recommended for this purpose.

4.09 Junctions of Fig. 8 DW with Buried Wire - No lightning protection is needed for the Fig. 8 DW, but a one-pair washer gap terminal block is required for termination and protection of the buried wire.

5. POWER CONTACT PROTECTION MEASURES APPLIED TO FIG. 8 DW

5.01 As stated in paragraph 2.02, no specific power contact protection is required for Fig. 8 DW except effective grounding of the support wire. Grounds should be placed at the beginning and at the end of nonshielded joint use sections with power circuits exceeding 2900 volts to ground, and in addition at one-half mile intervals. The grounds should be made by connecting to an MGN, or to other low impedance grounds if an MGN is not available. The support wire should also be grounded at or near crossings and conflicts.

5.02 Grounding of the support wire as described in paragraph 5.01 is not required, (1) where Fig. 8 DW is installed below aerial cable or other wire facilities and is therefore shielded from contacts, or (2) for exposures of less than 2900 volts to ground.

5.03 Some of the measures required by the National Electrical Code (NEC) to protect stations against the effects of power contacts are included in the wire plant and are discussed in the following paragraphs. Where large power fault currents are likely such as near junctions with open wire, #20-gauge bridle wire of adequate length is specified to limit the current through service drops and station protectors. Where large power fault currents are not likely, such as at intermediate drop locations along Fig. 8 MPDW leads, shorter #24-gauge copper leads connected to washer gap terminal blocks meet code requirements economically and are considered adequate. It is not practicable to provide a #24-gauge copper fuse link between Fig. 8 one-pair DW and drop wire within a one-pair support wire-mounted distribution wire terminal. Therefore, #20-gauge bridle wire must be run from the distribution wire terminal to a drop wire terminal at each point where a drop wire connects to Fig. 8 one-pair DW.

5.04 Part of the justification for omitting power contact protectors from Fig. 8 DW is the provision of suitable fuse links to isolate service drops, and the use of relatively high current-carrying capacity fuseless station protectors. Color coded #24-gauge leads connected to terminal blocks are also adequate to maintain the unexposed status of buried plant if used at junctions between Fig. 8 DW and buried plant to connect between the two facilities. Splicing connectors now available make practicable bridge tap splicing of Fig. 8 DW conductors to #24-gauge leads connected to terminal blocks.

5.05 Junctions of Fig. 8 DW with Buried Cable or Buried Wire

5.051 At junctions with buried cable or buried wire, where Fig. 8 DW is an extension of or a tap off the buried facility, the buried facility should be terminated directly on binding posts of terminal blocks mounted in a buried plant terminal housing. It is desirable to use washer gap terminal blocks for this purpose as indicated in paragraph 4.08. The Fig. 8 DW conductors requiring termination should be spliced to #24-gauge copper leads at least 8" long. The other ends of the #24-gauge leads should be terminated on the appropriate binding posts of the terminal block. This arrangement provides a fuse link between the Fig. 8 DW and the buried plant as required by REA TE & CM-816, "Electrical Protection of Buried Plant."

5.052 Where the buried cable or wire is a tap off Fig. 8 DW, it may be more economical to provide a washer gap terminal block mounted in a ready-access enclosure mounted on the Fig. 8 DW, in lieu of in a buried plant terminal housing. The connection and splicing details including the #24-gauge fuse links would be the same as described in paragraph 5.051.

5.06 Junctions of Fig. 8 DW with Open Wire - At junctions with open wire, connections to Fig. 8 DW should be made with #14-gauge bridle wire to minimize the probability of the connection being burned open by lightning. Open wire type power contact protectors should be furnished on the open wire in accordance with REA TE & CM-820, "Open Wire Circuit Protection" if it is exposed to power contacts. Power contact protectors are not included as part of Fig. 8 DW protection. The #14-gauge bridle wire and the Fig. 8 DW should be terminated on the binding posts of terminal blocks in ready-access enclosures. If service drops are installed on the open wire junction pole and are connected to pairs extended by open wire, #20-gauge bridle wire should be used to provide a fuse link between the terminal block and a drop wire terminal.

6. BONDING OF SUPPORT WIRES OF FIG 8 DW

6.01 The support wires of Fig. 8 DW should be made electrically continuous throughout their lengths.

6.02 At junctions with aerial or buried cable, buried wire, and other wire supported distribution wires, the support wire of Fig. 8 DW should be bonded to cable support strands, cable or wire shields, and/or support wires as applicable.

6.03 Where Fig. 8 DW is carried on the same pole as strand supported cable, it is not necessary to bond the support wire of the Fig. 8 DW to the cable strand because insulation on the DW would prevent a lineman from simultaneously making contact with the cable strand and the support wire.

7. GUYS

Where Fig. 8 DW is placed on existing joint use power poles beneath existing telephone plant such as cable or open wire which shield it from contact, the guying requirements of REA TE & CM-650, "Guys and Anchors on Wire and Cable Lines" regarding grounded guys versus strain insulators in guys apply. Where Fig. 8 DW is <u>not</u> shielded by other telephone plant and is exposed to power voltages in either joint use or at crossings, strain insulators are required <u>unless</u> the support wire is grounded to a grounded cable strand or shield or to an MGN within one-fourth mile of the guy location.

MULTIPAIR DISTRIBUTION WIRE PROTECTION

Purpose: The purpose of this addendum is to modify existing instructions regarding power contact protection of aerial distribution wire.

Change: Change paragraph 4.0231 to read as follows:

4.023 Power Circuits Exceeding 2900 Volts to Ground

4.0231 All pairs of a run of aerial distribution wire should be protected at or near the beginning and end of an exposure except where the exposed portion of the run is less than 1500 feet, in which case protection should be applied at only one (either) end.

Change: Change paragraph 4.0232 to read as follows:

4.0232 All drops from exposed aerial distribution wire should be protected unless located within 1000 feet of a protector installed in accordance with paragraph 4.0231.

Eliminate: Eliminate paragraphs 4.023, 4.0231, and 4.0232.

MULTIPAIR DISTRIBUTION WIRE PROTECTION

CONTENTS

1. GENERAL

1.01 This section is intended to provide REA borrowers, consulting engineers, contractors, and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It describes various protective measures to be used on aerial multipair distribution wire (MPDW) circuits.

1.02 These measures are intended for the protection of users and subscribers' property, protection of personnel working on the lines, and the protection of circuit facilities. Consideration of other factors can be found in REA TE & CM-633, "Design and Construction of Aerial Distribution Wire, Multipair" and other sections of the REA TE & CM. This revision is being made to bring our practices in line with experience gained since 1956.

2. LIGHTNING PROTECTION CONSIDERATIONS

2.01 The impulse dielectric strength of MPDW between conductors and between conductors and support wire is about 30 kv. This dielectric strength is adequate to prevent damage from lightning surges except for direct strokes and those arising from connections to severely exposed stations such as fire towers, radio stations, etc. Application of protection for the wire itself therefore generally is not necessary.

2.02 Although distribution wire itself is expected to be free from dielectric failure, it will tend to feed damaging surges to weaker dielectric plant such as paper insulated cable. Generally at such junctions protection must be applied.

3.03 With all types of outside plant wire and cable the most effective measure in the prevention of power contact lies in the provision of sound construction, proper clearances, and the avoidance of non-standard conditions. The high dielectric strength of distribution wire makes electrical contact between phase conductors of a power distribution circuit and the multipair conductors unlikely, except where the wire insulation is abraded or defective. Although power contact protection is not generally required, under certain conditions protective measures are necessary as outlined in the following paragraphs.

4. SPECIFIC APPLICATIONS OF PROTECTION MEASURES

4.01 Lightning Protection

4.011 Junctions with Any Type of Cable - Lightning arrester protection at junctions between MPDW and cable of any type, if required, has the function of protecting the cable rather than the MPDW. The protection practices for such junctions are therefore covered in REA TE & CM-815, "Cable Circuit Protection" and REA TE & CM-640, "Design of Buried Plant."

4.012 Junctions with Open Wire, Drop Wire, or Single Pair Distribution Wire - No protection is required at junctions between MPDW and open wire, drop wire, or single pair distribution wire except where extensions are connected to severely exposed stations such as fire towers, radio stations, etc. Pairs extending to such exposures should be protected at their junctions with the distribution wire by means of protected distribution wire terminals.

4.02 Joint Use Power Contact Protection

4.021 General - The same general protection principles specified for the joint use of poles with high voltage power (above 2900 volts to ground) distribution circuits with open wire are applicable to MPDW. (See REA TE & CM-690, "Joint Use of Poles" and REA TE & CM-820, "Open Wire Circuit Protection.") Where MPDW is unshielded, that is, without cable or open wire between it and the power conductors, the principal protection objective is that coordination be achieved.

In order that electrical contact between the power and telephone conductors may occur, the power voltage must

be sufficient to arc through the MPDW insulation. Under such conditions it is probable that the arcing will burn through the insulation of the support wire, providing a ground path adequate for deenergizing the power circuit.

4.022 Power Circuit Below 2900 Volts to Ground - For power circuits operating below 2900 volts to ground, station protectors provide adequate protection to subscriber premises, and the conductor insulation generally can be relied on to prevent electrical contacts to the conductors even though a physical contact may occur. Therefore no special protection measures are required beyond conformance to the bonding practices covered in later paragraphs.

4.023 Power Circuits Exceeding 2900 Volts to Ground

4.0231 Where MPDW is not shielded by cable or open wire the MPDW (and telephone plant to which it is connected) will require protection against power contact as follows: Power contact protection should be installed on all such circuits at or near both ends of the exposed section, unless the section is 1,500 feet or less in length in which case protection should be installed only at or near one (either) end of the section.

4.0232 If station drops are connected to the multipair wire within the exposed section, power contact protection should be installed on the pair or pairs serving the stations at or within 1,000 feet of each drop wire location. Power contact protection should be provided in the form of protected distribution wire terminals (Figures 1 and 3).

4.024 No special protective measures are required where MPDW is installed below aerial cable or open wire and is therefore shielded from contact.

4.03 Power Crossings Exceeding 2900 Volts to Ground

4.031 Joint pole crossings should be utilized wherever practicable for reasons given in REA TE & CM-801, "Conditions Requiring Electrical Protection." At all crossings where distribution wire is shielded from power contacts by other telephone plant, no additional protection devices are required on the distribution wire.

4.032 At or near all crossings with MGN type power lines where the distribution wire is not shielded from contacts by other telephone plant, protection should be provided on all pairs by means of a protected wire terminal. Where additional crossings of the same MPDW and the same power circuit occur within 1,500 feet of a protected crossing, protection at the additional crossings is not required.

4.04 Loading Coil Protection - Loading coils for multipair distribution wire are available having dielectric strength such that protection is not required.

4.05 Bonding to Aerial Cable - At junctions between MPDW and aerial cable the support wire should be bonded to the cable strand. Where multipair distribution wire is carried on the same pole line with aerial cable, the support wire should be bonded to the cable suspension strand at each end of the wire run and at intervals of approximately one-fourth mile (Fig. 2).

4.06 Bonding of Protector Ground Terminals - The MPDW steel support wire affords a method of obtaining a common grounding conductor for protection devices. Where protectors are required the protector ground terminal or plate of all assemblies should be connected either directly or indirectly to the metallic support wire. If the protector assembly design is such that a satisfactory electrical connection is not made to the support wire in mounting the protector assembly, the connection should be made by means of a #10 ground wire.

4.07 Grounding the Support Wire

4.071 Where power contact protection is required, protectors should have their ground binding posts connected to the multipair support wire as described in paragraph 4.06. In order to assist in deenergizing the power circuit in the event of a contact between the two facilities and to reduce induced voltage in joint use sections, the multipair support wire should be grounded by bonding to the power line MGN at approximately one-fourth mile intervals via a vertical pole ground wire (Fig. 1).

4.072 Grounding conductors from power system lightning arresters should not be used unless they are connected to the MGN conductor.

4.073 In joint use with non-MGN systems, the support wire should be effectively grounded at approximately one-fourth mile intervals by connection to artificial grounds so constructed that coordination is achieved. (See Fig. 3, and REA TE & CM-690.)

4.074 At junctions with buried wire or cable the multipair support wire should be bonded to the buried wire or cable shield.

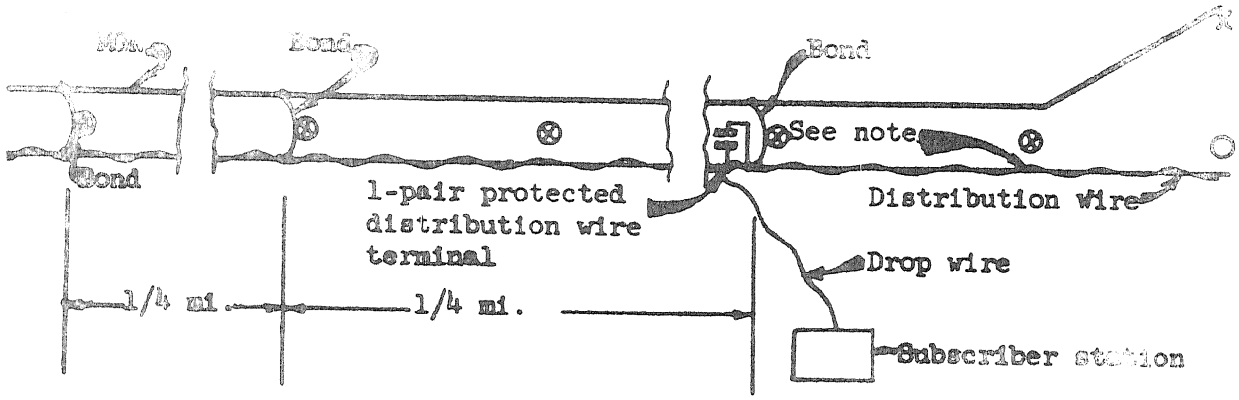
4.08 Grounding of Guys - When distribution wire is placed on existing pole lines beneath existing shielding plant such as cable or open wire, no change in guying arrangements regarding solidly grounded guys versus use of strain insulators in guys is necessary. (See REA TE & CM-650, "Guys and Anchors on Wire and Cable Lines.") Where distribution wire is not shielded by other telephone plant in either joint use or at crossings with separate pole line construction, strain insulators may be omitted if the support wire is grounded to a grounded cable sheath or shield or to a power MGN within one-fourth mile of the guy location.

5. DRAINAGE

5.01 The voltage induced into MPDW in joint use with power distribution circuits is much less than would be induced into open wire with the same separation because of the relatively high capacitance between the distribution wire conductors and the grounded support wire. When the support wire is grounded in accordance with paragraph 4.07 the induced voltage in MPDW would be appreciably less than that which would be induced into open wire under the same conditions. The surprise shock hazard and the probability of damage to grounded ringers on MPDW is therefore negligible. In view of the above, no drainage units are normally required on multipair distribution wire.

5.02 An exception to 5.01 would be where a portion of a circuit is in open wire joint use and a portion is in distribution wire. In such instances the combined open wire and distribution wire sections should be considered to be equivalent to an open wire circuit having a length equal to the length of the open wire section plus one-half the length of the distribution wire section. The open wire drainage protection requirements of REA TE & CM-820 should be applied to this equivalent open wire circuit.

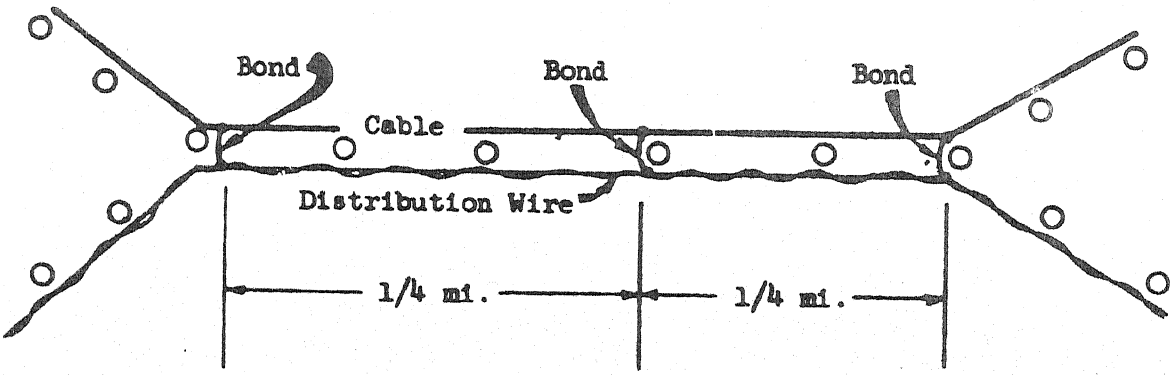
5.03 During construction operations, precautionary measures against induced voltages should be taken in accordance with REA TE & CM-633.



Note: Protect all pairs at beginning of joint use with a protected distribution wire terminal.

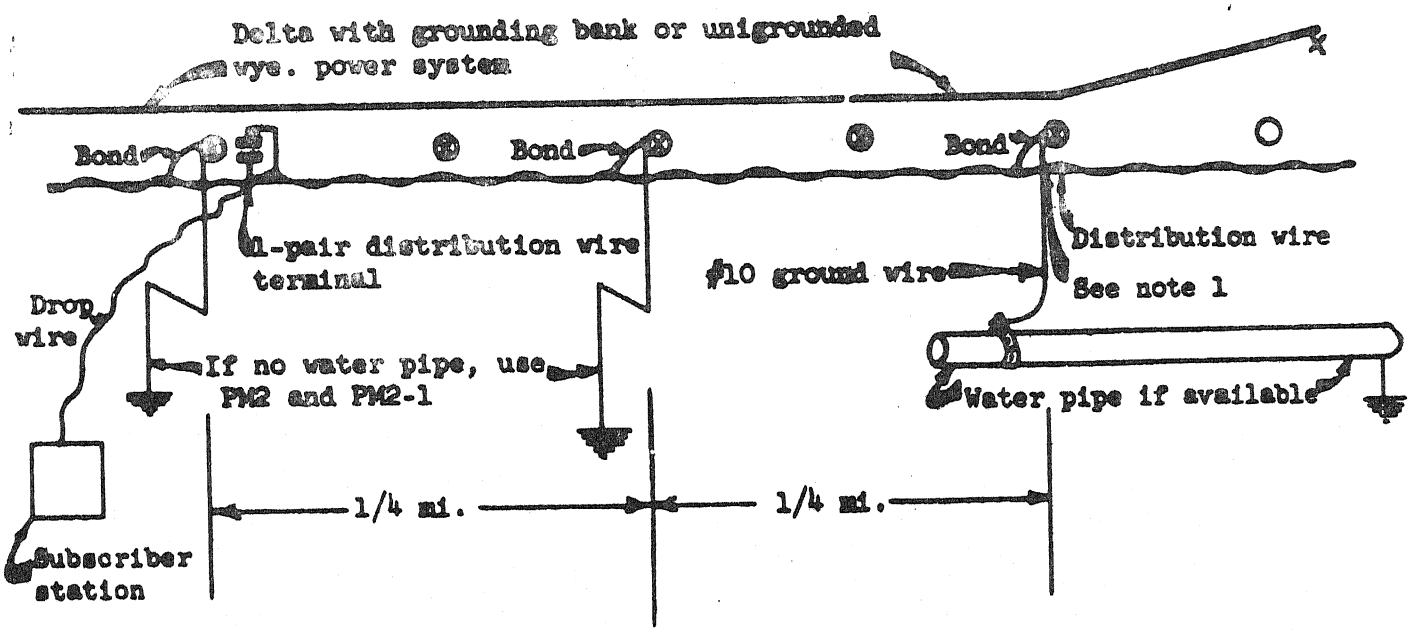
JOINT USE WITH MULTIGROUNDED NEUTRAL TYPE DISTRIBUTION LINE

FIGURE 1



JOINT USE WITH STRAND SUPPORTED CABLE

FIGURE 2



Note 1: Protect all pairs at beginning of joint use with a protected distribution wire terminal.

*Joint construction should not be used with nonmultigrounded neutral type distribution circuits unless sufficiently low resistance grounds can be obtained to insure coordination.

JOINT USE WITH NONMULTIGROUNDED NEUTRAL TYPE DISTRIBUTION LINE*

FIGURE 3